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NELSON MECHANICAL TIMING GEAR FOR AERIAL FIRE CONTROL

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The following publication, entitled "Nelson Mechanical Timing Gear for Aerial Fire Control," is published for the information and guidance of all concerned.

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BY ORDER OF THE SECRETARY OF WAR:

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General, Chief of Staff.

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NELSON MECHANICAL TIMING GEAR FOR AERIAL FIRE CONTROL.

NELSON MECHANICAL GEAR.

GENERAL DESCRIPTION.

The Nelson mechanical gear is a device by means of which machine guns are timed for firing between the blades of the propeller. It was designed primarily for use in connection with the Liberty motor and is gradually being assembled on other type motors. For instructional purposes the gear is divided into five groups, as follows:

1. The generator drive shaft.
2. The generator.
3. The impulse cable.
4. The trigger motor.
5. The control cable.

First Unit—The generator drive shaft:

1. Drive shaft.
2. Bevel gear (24 teeth).
3. Belt felt washer.
4. Bronze bearing.
5. Drive shaft housing (4) bolts, washers, nuts, and cotter pins.

Second Unit—The generator:

1. Generator housing.
2. Generator cam shaft.
3. Generator cam shaft coupling flange, (2) bolts, washers, nuts, and cotter pins.
4. Cam, cam key, nut, and cotter pin.
5. Annular ball bearings (2).
6. Generator housing cap and gasket.
7. Generator housing cap plug.
8. Lower retaining nut, collar, packing, and lock screw.
9. Torque arm support, bolt, washer, nut, and cotter pin.
10. Torque arm.
11. Torque arm bolt, washer nut, and cotter pin.
12. Torque arm positioning bolt, washer, nut, and cotter pin.
13. Tappet.
14. Tappet bronze bushing.
15. Rocker lever.
16. Rocker lever bronze bushing.
17. Generator thrust rod yoke, bolt, stud, nut, and cotter pin.
18. Tappet friction stud, spring, and screw.
19. Plunger friction roller and axis pin.

Third unit—The impulse cable:
1. Impulse cable.
2. Impulse cable adjustable yoke, bolt, nut, and lock spring.
3. Impulse cable yoke bolt, stud, and cotter pin.

Fourth unit—The trigger motor:
1. Trigger motor housing.
2. Trigger motor housing lock nut.
3. Trigger motor crank.
4. Trigger motor lever.
5. Trigger motor plunger.
6. Trigger motor plunger spring.
7. Trigger motor plunger spring guide.

Fifth unit—The control cable:
1. Control cable.
2. Control cable plunger.
3. Control cable plunger spring.
4. Control cable plunger spring guide.
5. Control lever bracket, (2) caps and (4) screws.
6. Control cable levers.
7. Control lever bracket wire guides (2).
8. Control cable adjusting screws and lock nuts (2).
9. Control cable casing and case caps (2).

KEY TO DIAGRAM.

1. Generator drive shaft.
2. Bevel gear (24 teeth).
3. Bronze bushing.
4. Drive shaft housing.
5. Generator housing.
6. Generator cam shaft.
7. Generator cam shaft coupling flange.
8. Generator cam.
9. Generator cam shaft ball bearings.
10. Generator housing cap and gasket.
11. Generator housing cap plug.
12. Lower retaining nut.
13. Torque arm support.
14. Torque arm.
15. Tappet.
16. Tappet bronze bushing.
17. Rocker lever.
18. Generator thrust rod.
19. Impulse cable.
20. Trigger motor.
21. Trigger motor housing.
22. Trigger motor lock nut.
23. Trigger motor crank.
24. Trigger motor lever.
25. Trigger motor plunger.
26. Trigger motor plunger spring.
27. Trigger motor plunger spring guide.
28. Control cable.
29. Control cable plunger.
30. Control cable plunger spring.
31. Control lever bracket.
32. Control levers.
33. Joy sticks.

The generator drive shaft (1) is rotated at engine speed by the engine cam shaft drive shaft, to which it is connected by bevel gears (2). There are six male splines machined on the upper end of the drive shaft (1) that fit into the six female splines on the generator cam shaft coupling flange (7). This connection is a loose fit and gives a semiuniversal joint between the drive shaft (1) and the generator cam shaft (6). The generator cam-shaft flange has 20 one-fourth-inch holes equally spaced and the coupling flange has 18 holes of the same diameter and are held together by 2 one-fourth-

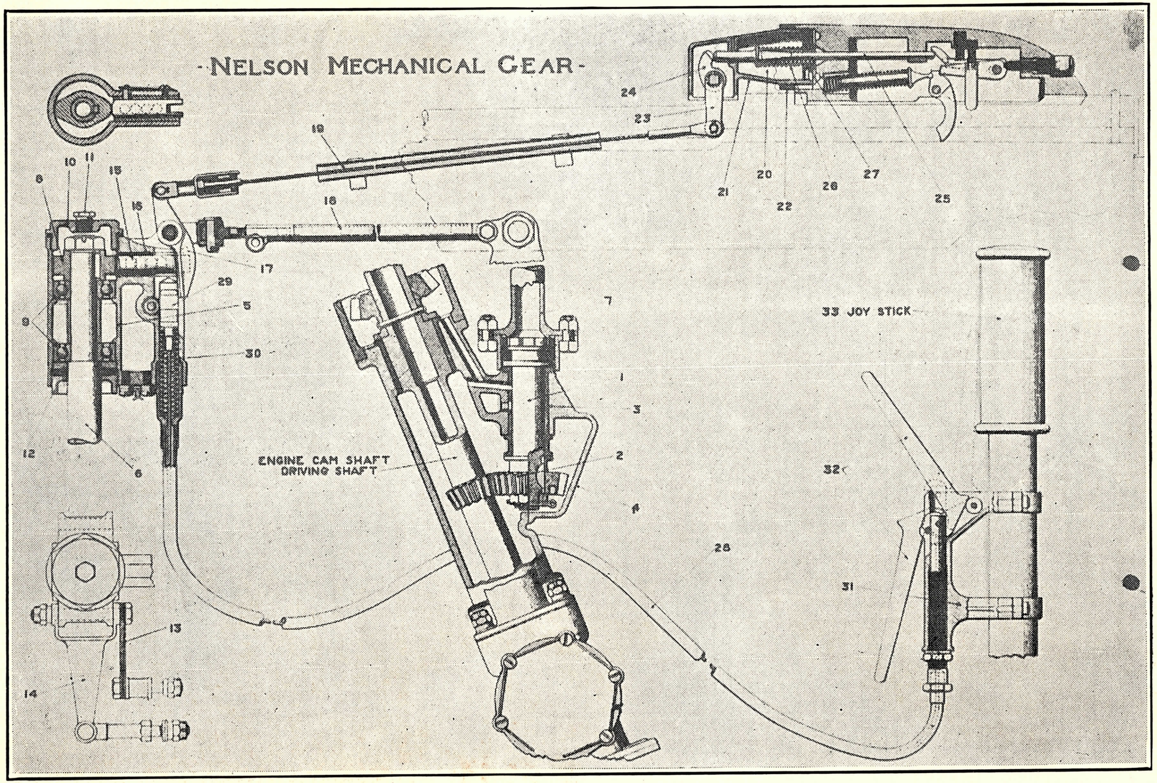
-NELSON MECHANICAL GEAR-
ENGINE CAM SHAFT
DRIVING SHAFT
33 JOY STICK

FIG. 1.

inch bolts, nuts, and cotter pins. By changing the positions of the bolts a vernier adjustment of 2° can be obtained in timing the generator cam shaft relative to the propeller.

The generator cam shaft (6) is supported by two sets of similar ball bearings (9) in the generator housing (5) and has at its upper end the two-hump generator cam (8). The generator housing (5) is supported by a three-point suspension, as follows:

(*a*) The generator cam shaft (6) resting on the generator drive shaft (1).

(*b*) The torque arm (14) and the torque-arm support (13), which are fastened to the engine cam-shaft housing.

(*c*) The generator thrust rod (18), which is fastened to the front gun mount.

The generator housing (5) is made oil-tight by means of the lower retaining nut and lamp-wick packing (12) and the generator housing cap and gasket (10). Working in the tappet bronze bushing (16) is the tappet (15). The tappet (15) is slotted at one end and beveled at the other. The rocker lever (17) fits loosely in the former, and the latter follows the cam contour. The generator thrust rod (18) is fastened to the generator housing (5) by the generator thrust-rod yoke, bolt, washer, nut, and cotter pin. This bolt passes through a bronze bushing, which also acts as an axis for the rocker lever (17).

Running from the rocker lever (17) to the trigger motor crank (23) is the impulse cable (19). This is a 19-strand, nonflexible steel cable and is adjusted by means of the adjusting yoke.

The trigger-motor housing (21) is threaded to screw into the new Marlin lock container. At the front end of the housing is the trigger-motor lever (24) and the trigger-motor crank (23). The crank shaft on the trigger-motor crank (23) is squared to take the trigger-motor lever (24). One end of motor crank (23) is squared to take the trigger-motor lever (24), and the trigger-motor plunger (25) bears on the trigger-motor lever (24), and the other end bears against the synchronizing trigger of the lock container.

The control cable (28) runs through its casing from the control cable lever (32), which is fastened to the joy stick (33) to the cable plunger (29) on the generator. A means of adjusting the casing is provided at the end held by the control cable bracket (31) at the other end is the control cable plunger spring (30) which actuates the control cable plunger (29).

ACTION OF THE GEAR.

Assuming the motor is running; the position of the tappet is away from the cam, held there by the friction stud under tension of the friction of the friction stud spring. The control cable plunger acting as a stop prevents the rocker lever from forcing the tappet in against the cam. When the control lever is pressed the control cable wire is drawn through the casing, and, being attached to the control cable plunger, it draws the plunger out of the path of the rocker lever, at the same time compressing the control cable plunger spring. This permits the tail of the rocker lever under tension of the trigger motor plunger spring to be forcing the rotation of the cam each time the peak strikes the tappet, the tappet is forced against the tail of the rocker lever, giving the rocker lever an oscillating movement on its axis. The head of the rocker lever being attached to the impulse cable is moved forward carrying the impulse cable and trigger motor crank (to which the other end of the impulse cable is attached) in the same direction. The trigger motor lever acting as an integral part of the trigger motor crank impinges against the synchronizing trigger and firing the gun, the trigger motor plunger spring is compressed by the trigger motor plunger. An adjustment is made on the impulse cable which allows an additional forward movement of the trigger motor plunger of one-thirty-second inch after the trigger releases the hammer. Actuated by the trigger motor plunger spring as soon as the peak of the cam rides off the tappet the trigger motor plunger through the trigger motor lever and crank and the impulse cable returns the rocker lever to its former position and forces the tappet to ride the cam contour ready to be struck by the next peak. The action is repeated as each peak of the cam comes in contact with the tappet, and will continue until the control lever is released when the control cable plunger under tension of the control cable plunger spring, assisted by the plunger roller rides up under the rocker lever, thus preventing the rocker lever from forcing the tappet against the cam. The last time the peak of the cam strikes the tappet, the tappet is forced to the rear against the rocker lever, and is prevented from moving forward due to inertia by means of the friction stud.

TIMING.

In timing the Nelson gear, the aiming point is 6 inches from the trailing edge of the propellers. Rotate the propeller until the aiming point is in line with the bore of the gun. This is determined by bore sighting, which may be done by means of a barrel reflector or by removing the bolt, raising the hammer, and sighting direct through the barrel. When the position of the propeller has been found, care must be taken not to move it during the process of timing. Remove the generator housing cap and the two bolts from the generator camshaft coupling flange. Loosen the impulse cable by unscrewing the impulse cable-adjustable yoke, as far as possible without disassembling. Rotate generator cam shaft until the highest point of the cam is bearing on the center of the tappet. At this time the tappet will be at the end of its backward stroke and the rear end will protrude out of the bronze bushing for a distance of about one-sixteenth inch. Measure this distance very carefully. Rotate generator cam shaft slowly in the opposite direction, as before, until the amoung of the tappet protruding from out the bronze bushing has been reduced one-thirty-second of an inch. Hold the cam shaft at this point and insert the two bolts in the generator cam-shaft coupling flange. This flange has 20 one-quarter-inch holes, 18° from center to center, and sets on the generator drive-shaft coupling flange, which has 18 one-quarter-inch holes, 20° from center to center. In any given position of the flanges there will be two pair of holes coinciding. By moving one of the flanges until the next two pair of holes coincide we find that with a change in the relative position of the two flanges there will be a new set of holes in which the bolts can be placed, therefore the position of the cam on the generator cam shaft relative to the propeller may be changed in increments of 2°.

With the cam forcing the tappet to one thirty-second inch from the end of its travel, cock the gun and screw up the impulse cable adjustable yoke until the trigger is tripped. Lock the adjusting screw with the lock spring.

CHECK THE TIMING.

Cock the gun, press the control lever, and rotate the propeller slowly until the trigger is tripped. Hold the propeller in place the instant the trigger is tripped. Boresight the gun; the aiming point should be directly in line with the bore of the gun. Note the position of the tappet; rotate the propeller a little further and see if the tappet has one thirty-second inch more travel on its backward stroke.

POSSIBLE BREAKAGE AND FAULTS.

1. Trigger motor plunger spring breaking.
2. Improper soldering at ends of control cable.
3. Weak or broken control cable plunger spring.
4. Improper soldering of impulse cable at both ends.

PRECAUTION.

Possibility of control cable plunger catching on rocker lever when control lever is released, thus firing a single shot. This condition might prove fatal, especially in gear training models for classroom work.

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